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Patentanmeldung Nr. Patent application No. Demande de brevet n°

02021498.7

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Blatt 2 der Bescheinigung
Sheet 2 of the certificate
Page 2 de l'attestation

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Anmelder: Applicant(s): Demandeur(s):
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Titre de l'invention:
Method and apparatus for carrying out diagnosis of a technical installation

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Description

Method and Apparatus for carrying out diagnosis of a technical installation

Background of the invention

In industrial plants, condition monitoring of main systems, sub-systems and components is essential to guarantee reliable operation.

In order to adjust operation parameters, schedule maintenance and repair, and to minimize safety risks, accurate data about the condition of numerous plant assets must be gathered and analyzed. The nature of data needed is manifold.

Typical examples are vibration data (e. g. turbines or pumps), temperature data, (e. g. boiler), volume data (e. g. throughput of a pipeline).
There are technical means to collect most of the desired data. However, for a complete picture, the amount of data needed is enormous.
This is a problem both in terms of installation costs of sensors, and in terms of efforts to analyze the resulting sensor data. As a consequence, the majority of plant owners cannot afford an all-embracing monitoring of all plant assets. Therefore, unscheduled drop outs of production are inevitable, often resulting in high penalties.

State-of-the-Art approaches to the problem

Condition monitoring in industrial plants is widely being carried out by two methods:

- Sensors attached at the components to be monitored collect data and report e.g. on-line or off-line statuses.

Such sensors can be vibration sensors for rotating machinery or thermography (e.g. temperature) sensors for boilers. If a component is monitored on-line, sensors are connected to an evaluation system, which analyzes the data and prompts appropriate messages to the operator. Off-line sensors do not necessarily need to be connected to an evaluation system; data can be collected on demand.

Any kind of sensor based monitoring is in general extremely costly. Not only the actual technical equipment needed, but also the appropriate commissioning and adjusting of the sensor to the specific needs and environmental conditions, take more effort than typical plant owners are able or willing to spend.

And/or

- Specialist engineers inspect machinery by frequent walk downs.
  The main "sensor" used for inspection here is human perception. Due to their knowledge and experience, these engineers are able to detect a broad range of failures. However, symptoms of many failures simply cannot be sensed without technical aids, for example, bearings, which start becoming faulty or change of magnetic flux in a pump. Furthermore, long term changes in a machine's component characteristic is very hard for a human being to sense, since there is no direct comparison available with a regular operation mode.

Embodiments of the invention

Sub-systems / machinery components are designed in such a way that they indicate faults acoustically and/or optically.

Instead of attaching sensors to machinery which display measured data on a screen or on legacy computer systems, machin-

ery is designed such that faults can clearly be identified by characteristic sounds and/or that a machine's components are designed in such a way that they change their outer appearance, e.g. with regard to their coating color, when a fault occurs.

Each type of fault may e.g. cause a unique sound ("groan"), i. e. the sound's frequency and / or its volume should allow identifying the fault without ambiguity. The sounds should be identifiable by personnel without technical aids such as vibration monitoring devices or sound analysis systems.

Alternatively or in combination therewith each type of fault may cause an optical signal assigned to said failure.

This enables a person carrying out a plant walk down to also detect faults which normally would be not be sensible by human perception.
For this monitoring method no costly additional sensors are required since machinery by design makes faults obvious for plant personnel. Therefore, walk downs are much more effective and give a more comprehensive image of a plant's condition.
Without plant-wide sensor installations, plant operators receive all information for making operational and maintenance decisions.

Examples:

- Rotating machinery, such as pumps or fans, are designed such that faults in their bearings lead to characteristic noises. This can be achieved by designing the casing such that faulty bearings result in body resonance effects. Faults in different bearings result in different resonance frequencies.
  Such resonance effects can be made perceivable for human beings for example by attaching plates to the casing which

vibrate according to body resonance of the casing (see figure 1 for an example of application).

- Supports of pipelines are often designed to adjust flexibly when the pipeline expands due to a change of its temperature.
Abnormal temperature changes lead to abnormal adjustment of the support. A characteristic squeaking of the support would make such abnormal temperature changes audible to plant personnel.

- Electrical machinery produce well defined electric-magnetic flux.
A flux sensitive coating may change color when the flux differs from the expected flux. Such discrepancies indicate the type of fault inside the machine, i. e. faulty rotors in electrical engines.

- Temperature sensitive coatings may change their color and thus reflect discrepancies from normal temperatures of machinery.
An abnormal local temperature in a specific area on a machine's surface may thus give hints to the type and location of a fault.
For example, local temperature discrepancies in a rotating machine can indicate a faulty bearing.

- Vessels containing liquid of noticeable color can be attached to components of a technical installation.
The vessels and the way of attachment are designed in such a way that the vessel breaks when the machinery or a particular material suffers excessive strain, for example due to vibration.
The liquid leaking from the machine's component is an optical indication for the strain the component is or was exposed to (see figures 2 and 3 for an example application).

The advantages of the invention compared to sensor based condition monitoring include cost saving and data reduction.

Machinery designed to indicate faults acoustically and/or optically do not require additional sensors to monitor their status.
Since only faults are reported by walk down personnel, and no data are reported on machinery which works faultlessly, the amount of data to be processed in evaluation and analysis systems is reduced.

Figures

Figure 1 shows an example of a pump's design, which indicates a faulty bearing acoustically.
At the casing, a plate is fixed in such a way, that it can swing when activated by its resonance frequency, and cause characteristic noise by hitting e.g. a metal stub on the casing.
The plate is dimensioned in such a way that it has the same body resonance frequency as the vibration frequency caused by a faulty bearing.
Hence, a faulty bearing causes the plate to swing and produce a characteristic noise.

Figures 2 and 3 show a vessel, filled with liquid, which is fixed on a steel construction by three fixations (figure 2). When the material of the steel construction is over-stressed, e. g. by putting weight on top, the vessel breaks and the liquid inside the vessel spills and thus gives indication for excessive stress the steel construction has suffered (figure 3).

Claims

1. Method for carrying out diagnosis of a technical installation,
characterized in that at least one acoustical signal assigned to at least one specific failure of at least one component of the technical installation is acquired, whereby the acoustical signal is being produced by a device assigned to said component and the device is being activated mechanically in case of occurrence of said failure.

2. Method according to claim 1,
characterized in that the device includes a plate capable of vibrating within hearing frequency range, said vibration frequency being characteristic for said specific failure.

3. Method according to claim 1 or 2,
characterized in that a number of devices are provided, each device being assigned to a specific failure.

4. Apparatus for carrying out diagnosis of a technical installation,
comprising at least one device assigned to at least one component of the technical installation for producing an acoustical signal characteristic for at least one specific failure of said component, whereby the device is activated mechanically in case of occurrence of said failure.

5. Apparatus according to claim 3,
characterized in that the device includes a plate capable of vibrating within hearing frequency range, said vibration frequency being characteristic for said specific failure.

6. Apparatus according to claim 4 or 5,

characterized in that a number of devices are provided, each device being assigned to a specific failure.

7. Method for carrying out diagnosis of a technical installation,
characterized in that at least one optical signal assigned to at least one specific failure of at least one component of the technical installation is acquired, whereby the optical signal is being produced by a device assigned to said component and the device is being activated mechanically in case of occurrence of said failure.

8. Method according to claim 7,
characterized in that the device includes a vessel containing a liquid, the vessel being capable of breaking if stress endured by said component exceeds a fixed value.

9. Method according to claim 7 or 8,
characterized in that a number of devices are provided, each device being assigned to a specific failure.

10. Apparatus for carrying out diagnosis of a technical installation,
comprising at least one device assigned to at least one component of the technical installation for producing an optical signal characteristic for at least one specific failure of said component, whereby the device is activated mechanically in case of occurrence of said failure.

11. Apparatus according to claim 10,
characterized in that the device includes a vessel containing a liquid, the vessel being capable of breaking if stress endured by said component exceeds a fixed value.

12. Apparatus according to claim 10 or 11, characterized in that a number of devices are provided, each device being assigned to a specific failure.

Abstract

Method and Apparatus for carrying out diagnosis of a technical installation

A specific failure occurring during operation of a technical installation is detected by acquiring an acoustic and/or optical signal emitted by a device assigned to at least one component of the technical installation whereby the device is being activated mechanically.

FIG 1

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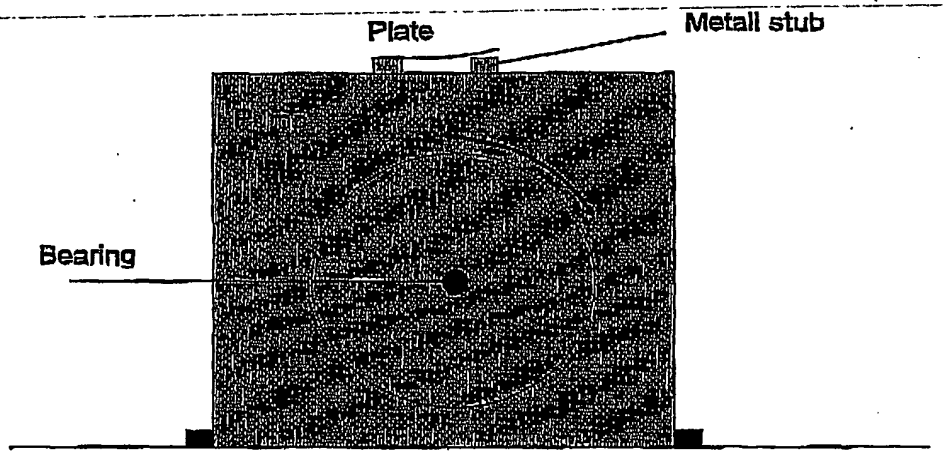

Figure 1

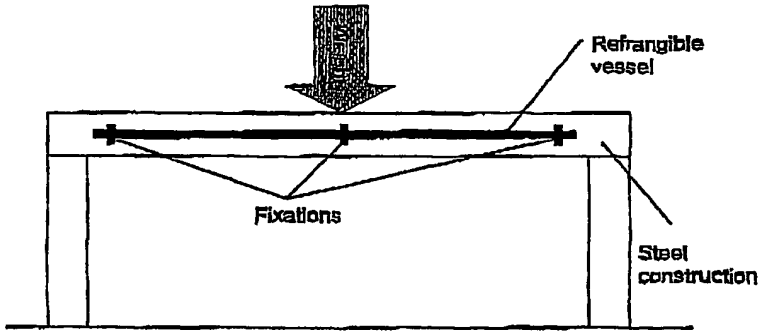

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Figure 2

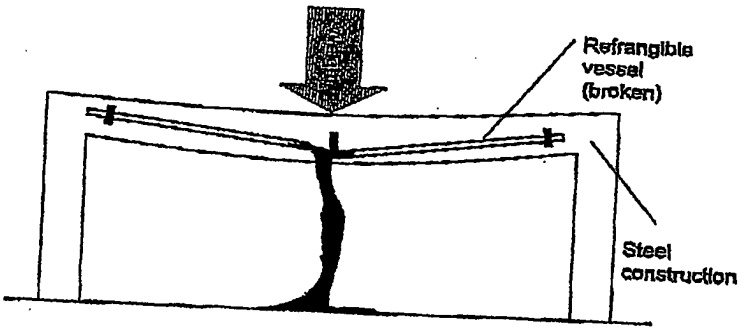

Figure 3

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